CHAPTER 1

INTRODUCTION

1.1 Background of the Study

According to Dhokpande and Kaware (2013), it was a very serious problem concerning the presence of heavy metals such as Copper, Silver, Zinc, Cadmium, Gold, Mercury, Lead, Chromium, Iron, Nickel, Tin, Arsenic, Selenium, Molybdenum, Cobalt, Manganese, and Aluminium in many wastewaters and also industrial effluents. These heavy metals carry toxic and carcinogenic agents in which these agents posed a deadly threat to human and nature especially when these metals are exposed to the water which is the main source of every living creature. Some of the toxic metals are Zinc, Copper and nickel in which they have a high toxicity level either in low concentration or high concentration. **Table 1.1** shows the maximum contaminant level limits of several heavy metals in industrial effluents.

Since before, the removal of heavy metals has been going on quite successfully conducted by some researchers and industries worldwide. Variety of methods have been proposed by these researchers to remove the heavy metals in many different kind of wastes. The methods range from chemically involved methods, mechanical methods and biological methods. Each and every method has its own specialty. For instance, the pyrometallurgical method is one of the mechanical method used to remove metals in large scale industries. This method applied a very high heat treatment at above 1200℃ and includes smelting and roasting of the waste to recover the precious metals (Liew, 2008). Aside from that, the efficiency of this process is not that high because of the high temperature treatment which can damage the metals.

The chemical methods involve using specific chemical solution as to remove these heavy metals. An example in one of the experiment run by Sheng and Etsell (2007), a medium, aqua regia is used to dissolve particular precious metals which are gold and also some platinum group metals. According to them also, aqua regia is a mixture of three parts concentrated hydrochloric acid and one parts nitric acid. Ammen

(1984) also stated that aqua regia is very flexible, easy and has low capital requirement which is the reason to be selected as the recovery medium for gold. However, a method has been proposed which is more environmentally safe and also economically possible. The use of microorganisms in metals recovery process has been the main technology in biological methods this past few years. In Willner et al. (2015), the method of bioleaching has been conducted to recover various kind of metals in a lot of wastes with the involvement of different groups of microorganisms. For example, *Penicillum sp.* and *Aspergillus niger* are some of the microorganisms used in bioleaching method. The demand for this green technology application has been increasing a lot lately.

Table 1.1: The MCL (Maximum Contaminant Level) standards for the most hazardous heavy metals (*Babel and Kurniawan, 2003*)

Heavy metal	Toxicities	MCL(mg/L)
Arsenic	Skin manifestations, visceral cancers, vascular disease	0.05
Cadmium	Kidney damage, renal disorder, human carcinogen	0.01
Chromium	Headache, diarrhea, nausea, vomiting, carcinogen	0.05
Copper	Liver damage, Wilson disease, insomnia	0.25
Nikel	Dermatitis, nausea, chronic asthma, coughing, human carcinogen	0.20
Zinc	Depression, lethargy, neurological signs and nervous system	0.80
Lead	Damage the fetal brain, diseases of the kidneys, circulatory system and nervous system	0.006
Mercury	Rheumatoid arthritis, and diseases of the kidneys, circulatory system and nervous system	0.00003

1.2 Motivation

Heavy metals removal from wastewaters nowadays was very costly and has become the subject of considerable interest due to the strict legislation and law (Dhokpande and Kaware, 2013). However, recent studies have proved the efficiency of biological methods which emphasize the cost effectiveness and environmental friendly. Other available methods are considered to be cost consuming and not environmental friendly such as pyrometallurgy and hydrometallurgy. The usage of microorganisms such as algae, fungi, bacteria actinomycetes might be a relevant medium to be used to remove these metals due to the ability and properties of some of these microorganisms which able to bind and concentrate metal ions even in inactive state (Dobson and Burgess, 2007). Even so, this method is still not applied in the large industrial scale because more work need to be done in order to better understand the feasibility, mechanisms, and technology know-how of the methods.

1.3 Problem Statement

In mining industry for instance, the effluent discharge usually contains arsenic, lead, Copper, Zinc and other heavy metals which holds a very high toxicity level (Celebi and Özdemir, 2014). However, according to standard B of Environmental Quality (Industrial Effluents) Regulation 2009 set by Department of Environmental (DOE), the amount of certain heavy metals for instance Copper and Zinc allowed is not to exceed 1.0 mg/L and 2.0 mg/L respectively, in the industrial effluents discharge. The industries currently applied many types of treatments such as in mechanical and chemical methods to remove the heavy metals. However, those approaches have a few major drawbacks especially in costing, efficiency, environmental impacts and maintenance. Taking pyrometallurgical method for example, it is one of the physical method that still active nowadays and uses a very high heat treatment to recover the metals. Though, the heavy impacts it emits to the environmental become the main disadvantages of this method (Liew, 2008). Instead, one of the most applied chemical method is chemical precipitation using lime as the agent. Despite that, this method requires a large amount of chemicals if want to reduce to an acceptable level of discharge. It also has slow metal precipitation, poor settling, the aggregation of metal precipitates and long term